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# FLAT BELT
[HIRA BERUTO]

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| TITLE | (54): | FLAT BELT |
| FOREIGN TITLE | [54A]: | HIRA BERUTO |

[Claims] /*

[Claim 1] A flat belt which rotates wrapped on a rotary driving unit such as a pulley in a circular columnar or cylindrical shape, where tension core wires extending in the longitudinal direction of the belt are buried in and integrated with the belt body. In order to bury the tension core wires in the prescribed location of the belt body, grooves in the width direction of the belt are formed at a constant interval in the longitudinal direction of the belt in the inside surface of the belt body contacting the rotary driving unit. These grooves are formed as straight line oblique grooves having a prescribed tilt angle against the rotary axis line or the generating line of the rotary driving unit.

[Claim 2] The flat belt according to Claim 2, wherein the grooves are formed as straight line oblique grooves in two directions which intersect each other.

[Claim 3] The flat belt according to Claim 1 or Claim 2, wherein convex anti-meandering guides in the longitudinal direction of the belt are provided on the inside surface of the belt body which contacts the rotary driving unit.

[Detailed Description of the Invention]

[0001] [Industrial Field of Application]

This invention relates to a flat belt that is effective in preventing noises that are generated during operation.

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* Claim and paragraph numbers correspond to those in the foreign text.

[0002] [Prior Art]

In general, flat belts that are used for motion power transmission, commodity transportation, and the like, have a plurality of parallel tension core wires buried in the width direction of the belt, where the wires are made from steel wires, aramid fiber, or glass fiber. These wires are buried in the belt in order to enhance the tensile strength of the belt in the longitudinal direction. When the flat belts are manufactured by an extrusion process, a cast-molding process, or a press-molding (vulcanization) process, special care is taken so that the tension core wires are arranged at the prescribed positions, namely that their placement in the thickness direction of the belt body is not irregular. For this reason, grooves are generally provided over the entire length of the belt in the longitudinal direction of the belt arranged at a constant interval, which serve as the reference for placement of the tension core wires during molding. Figure 11 and Figure 12 are a top view as seen from the inside and a side cross-sectional view of conventional flat belts with such grooves. Namely, when this flat belt 1 is used by wrapping it on a rotary driving unit such as a pulley (not shown), tension core wires 3 extending in the longitudinal direction are buried in the belt body 2; and right-angle grooves 4 are formed, on the inside surface of the belt where the belt body 2 comes in contact with the pulley, in the direction of the belt width B at a right angle to the longitudinal direction of the belt in order to ease the

manufacturing of the forming wheel. These right angle grooves 4 are generally arranged over the entire length of the belt at a constant interval in the longitudinal direction of the belt. However, in the case of such a conventional flat belt 1, since the right-angle grooves 4 are formed in the width direction of the belt at a 90° angle to the longitudinal direction of the belt body 1, the top edge 4a of the right-angle groove 4 comes in contact with the driving pulley. This collision generates intermittent hitting sounds. This hitting sound could reach a noise level that cannot be ignored especially during high-speed driving operations. Thus, such belts are restricted from use in an environment which requires low noise levels.

[0003] [Problems to be Resolved by the Invention]

The objective of this invention is to provide a flat belt having a structure with intermittent grooves in the belt body in order to place the tension core wires in the belt body, where these grooves serve to reduce the hitting noise caused by contact with a rotary driving unit such as a pulley and, therefore, is suitable for use in an environment where a low noise level is especially desired.

[0004] [Means for Solving the Problems]

The flat belt of this invention is configured to rotate while wrapped on a rotary driving unit such as a pulley in a circular columnar or cylindrical shape, where tension core wires extending in the longitudinal direction of the belt are buried in and integrated

with the belt body. In order to bury the tension core wires in the prescribed location of the belt body, grooves in the width direction of the belt are formed at a constant interval in the longitudinal direction of the belt in the inside surface of the belt body contacting the rotary driving unit. These grooves are formed as straight line oblique grooves having a prescribed tilt angle against the rotary axis line or the generating line of the rotary driving unit.

[0005] [Working]

Since the grooves are formed as straight-line oblique grooves having a prescribed tilt angle against the rotary axis or the generating line of the rotary driving unit, the straight-line oblique grooves, which are set at a tilted angle to the rotary axis or the generating line of the rotary driving unit such as a pulley, the pulley is contacted at a contact point which has a size close to a point. This can reduce or suppress the generation of the sounds caused by the rotary driving unit and the straight-line oblique grooves hitting or contacting each other.

[0006] [Embodiments]

Embodiments of flat belts under this invention are explained next with help from illustrating drawings. Figure 1 and Figure 2 show a perspective view and a side view of the flat belt 10 in Embodiment 1 as it is wrapped between and driven by a pair of drive-side and driven-side pulleys 20 and 20. Figure 3 and Figure 4 show,

respectively, a top view as seen from the side of the inside contact surface between the flat belt 10 unit and the pulley 20, as well as a side cross-sectional view, of the flat belt 10. The belt body 11 can be made from rubber elastic materials such as urethane rubber, nitrile rubber, or chloroprene rubber through an extrusion process, a cast-molding process, or a press-molding (vulcanization) process as was shown in conventional cases. Further, in order to enhance the strength against the tensile force working in the longitudinal direction of the belt during operation, multiple parallel tension core wires 12 made from steel wires, aramid fiber or glass fiber are buried in the width direction of the belt in the belt body 11.

[0007] Further, straight-line oblique grooves 13 are provided over the entire longitudinal length of the belt generally at a constant interval in on the inside surface of the belt body 11 contacting the pulley 20. The straight-line oblique grooves 13 are cut over the entire width B of the belt, from one edge to the other edge, and are tilted at an angle $\alpha$ against the direction of the belt width B. In other words, these straight-line oblique grooves 13 are tilted at an angle $\alpha$ against the rotary axis line C-C of the pulley 20, the rotary cylindrical body, or the generating line 22 of the cylindrical body which is parallel to this rotary axis line C-C. The groove angle $\alpha$ should be around at least 10° and less than 90°, and preferably around 40~70°.

[0008] Therefore, although with the flat belt 10 under Embodiment

1, the inside of the belt body 11 contacts the pulley 20 during rotary operation, the straight-line oblique grooves 13 provided on the inside contact the rotating pulley 20 only through a contact point having a size close to a point at the generating line 22 of the cylindrical surface 21. For this reason, even when the top edges 13a and 13a of the straight-line oblique grooves 13 come in contact with the cylindrical surface 21 of the pulley 20, there would be almost no, or a very light, hitting sound generated. Thus, it would not cause a problem when it is used in an environment where low noise levels are required.

[0009] Now, test material A will be the conventional belt shown in Figure 11 and Figure 12; test material C will be the flat belt 10 of Embodiment 1 of this invention; and test material C will be a flat belt that does not have conventional right-angle grooves or the straight-line oblique grooves 13 of this embodiment. As shown in Figure 5, these three test materials A, B, and C are wound between a pair of pulleys 20 and 20. Then, a noise meter 30 is placed at 50 mm distance, for example, from the location where each of the test materials begins to contact the drive-side pulley 20, to measure and compare the sound pressure levels of the noises generated by each test material A, B, and C. Here, the groove angle α of the right-angle groove 4 of conventional test material A is set to 90°, while the groove angle α of the straight-line oblique groove 13 of the test material B under Embodiment 1 is set at 60°. Further, the size

specification used by each test material A, B, and C is the same. Namely, according to the Figure 3 and Figure 4 of Embodiment 1, the belt thickness shown by code T is 5 mm, the belt width shown by code B is 25 mm, groove width b is 1.5 mm, groove depth h is 1.5 mm, and the groove pitch P is 20 mm. Further, the driving condition is set as follows: The number of rotations N of the drive-side pulley 20 is set to 1500 rpm and 5000 rpm. The belt tensile force F is set to 30~40 kgf.

[0010] The obtained results are shown in the table below and the graphs in Figure 6 and Figure 7.

Table

| | Driving pulley number of revolutions | | | | | |
|---|---|---|---|---|---|---|
| Belt tensile force (kgf) | 1500 rpm | | | 5000 rpm | | |
| | A | B | C | A | B | C |
| 30 | 91 | 83 | 83 | 105 | 92 | 90 |
| 40 | 93 | 83.5 | 83 | 104 | 93 | 90 |
| 50 | 95 | 84 | 82 | 107 | 93 | 91 |
| 60 | 95 | 84 | 82.5 | 107 | 94 | 92.5 |
| 70 | 98 | 85 | 84 | 108 | 95 | 93 |

(in dB, test time background noise 75 dB)

[0011] From this result, it is clear that the sound pressure level of test material B of Embodiment 1 of this invention is lower than the sound pressure level of the test material A of the conventional belt by 8 dB ~ 13 dB. Further, when the test material B of Embodiment 1, with straight-line oblique grooves 13, is compared to the test material C which does not have any grooves, there is almost no difference in the sound pressure level.

[0012] In other words, as was shown in Figure 1, in the case of

the flat belt 10 of Embodiment 1, during the rotary operation, the top edges 13a and 13a of the straight-line oblique grooves 13 and the generating line 22 of the pulley 20 contact each other at a contact point X whose size is almost a point, and the hitting sound from the collision is reduced when this contact point X comes in contact continuously. In contrast, in the case of the flat belt 1 of the conventional test material A, the lines of the top edges 4a and 4a of the right-angle grooves 4 come into contact intermittently with the generating line 22 of the cylindrical surface of the pulley 20, increasing the hitting sound from the collision. Further, even with the flat belts having right-angle grooves 4 or straight-line oblique grooves 13 for the reason mentioned above, the generated noise can be reduced to a sound pressure level that is similar to the flat belt without grooves when straight-line grooves 13 are provided at a prescribed angle as under this invention.

[0013] On the other hand, Figure 8 shows Embodiment 2 of this invention, which has a structure with straight-line oblique grooves 14 and 15 intersecting in two directions on the belt body 11. This also produces a similar effect as Embodiment 1 above. Further, Figure 9 and Figure 10 show Embodiment 3. In Embodiment 3, straight-line oblique grooves 13 with the tilt angel α are provided on the belt body 11 as in Embodiment 1. Further, in addition to the above, two anti-meandering guides 16 in a convex shape extending over the entire longitudinal length of the belt body 11 are provided in order to

prevent the driving belt from meandering.

[0014] [Advantageous Effects of the Invention]

The flat belt of this invention has tension core wires buried in the belt body and has grooves for molding these tension core wires at the prescribed positions, which are provided on the surface that contacts the rotary driving unit such as a pulley at a constant interval in the belt's longitudinal direction. Since these grooves are formed as straight-line oblique grooves having a prescribed tilt angle against the rotary axis or the generating line of the rotary driving unit, the oblique grooves contact the rotary axis line or the generating line of the rotary driving unit at a contact point whose size is almost a point. Thus, compared to a conventional structure where they contact at contact lines, it is possible to reduce the contact-hitting sound between the rotary driving unit and the oblique grooves to a minimum or can suppress the sound. Thus, it can be widely used in environments especially requiring low noise levels.

[Brief Description of the Figures]

[Figure 1] A perspective view showing how the flat belt of Embodiment 1 of this invention is used by wrapping it on a rotary driving unit such as a pulley.

[Figure 2] A side view of the flat belt in Figure 1 of Embodiment 1 as seen from the side.

[Figure 3] A top view of the flat belt of Embodiment 1 as seen from the inside.

[Figure 4] The side cross-sectional view of the flat belt of Embodiment 1.

[Figure 5] A schematic view of the device for measuring and comparing the flat belts of Embodiment 1 and conventional example.

[Figure 6] A performance graph showing the correlation of the belt tensile strength and the sound pressure level at 1500 rpm pulley revolution.

[Figure 7] A performance graph showing the correlation of the belt tensile strength and the sound pressure level at 5000 rpm pulley revolution.

[Figure 8] A top view of the flat belt of Embodiment 2 as seen from the inside.

[Figure 9] A top view of the flat belt of Embodiment 3 as seen from the inside.

[Figure 10] The side cross-sectional view of the flat belt of Embodiment 3.

[Figure 11] A top view of the conventional flat belt as seen from the inside.

[Figure 12] The side cross-sectional view of the conventional flat belt.

[Explanation of Codes]

10 … Flat belt

11 … Belt body

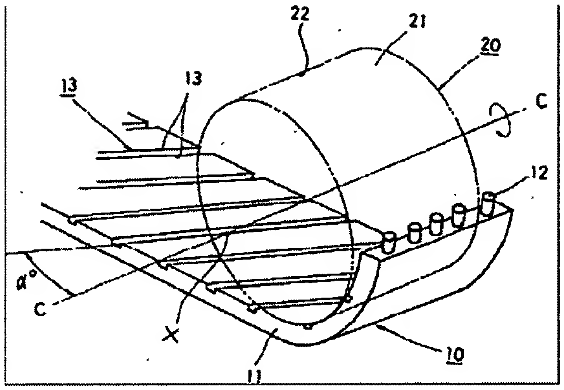
12 … Tension core wire

13 … Straight-line oblique groove

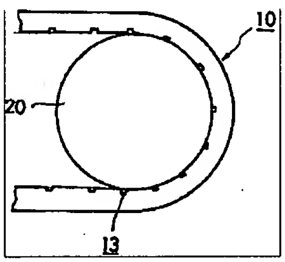
13a … Top edge of straight-line oblique groove

20 … Pulley, a rotary driving unit

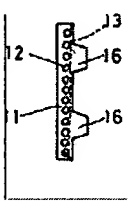
[Figure 1]



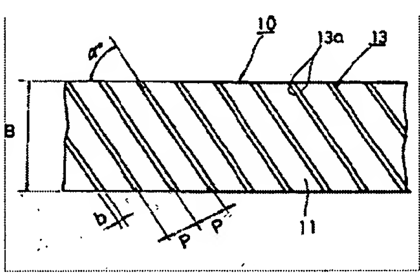

[Figure 2]



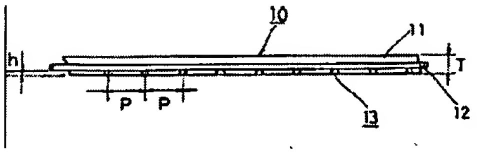

[Figure 10]



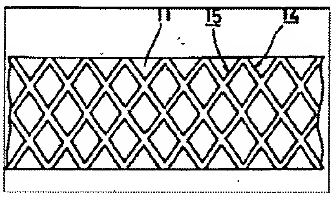

[Figure 3]



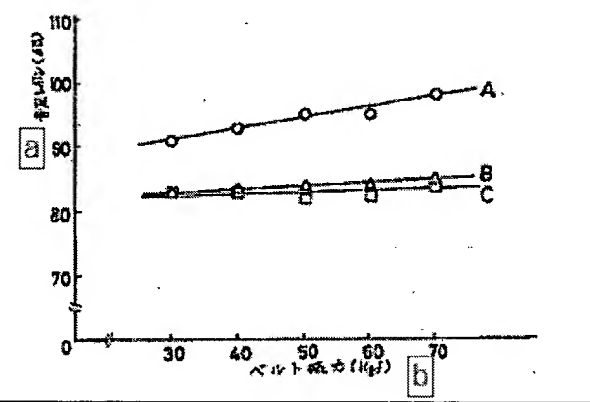
[Figure 4]




[Figure 8]

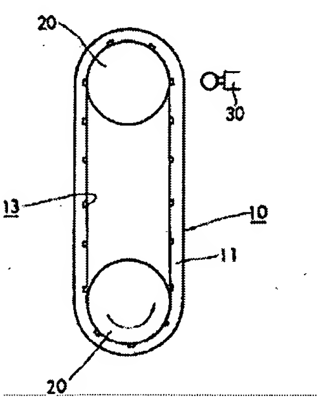



[Figure 6]

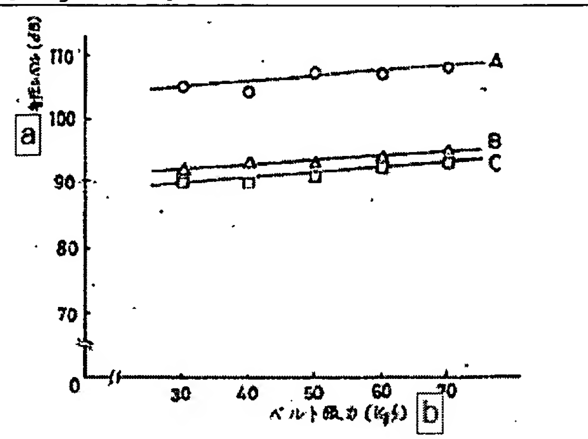



Key:
a) Sound pressure level (dB);
b) Belt tensile force (Kgf)

[Figure 5] /5

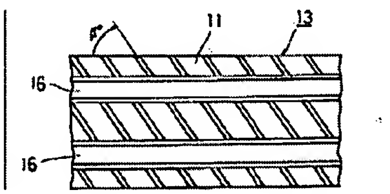


[Figure 7]

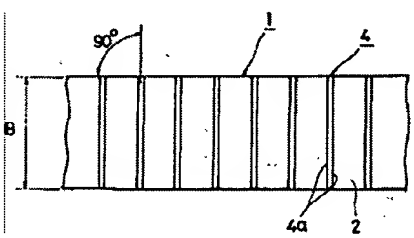



Key:
a) Sound pressure level (dB)
b) Belt tensile force (Kgf)

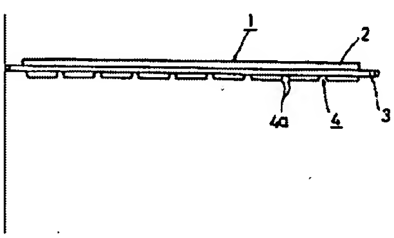
[Figure 9]




[Figure 11]




[Figure 12]



[Amendment of Proceedings]
[Submission Date] 17 May 1995
[Amendment 1]
[Amended Document Name] Detailed description
[Amended Section Number] 0005
[Nature of Amendment] Alteration
[Content of Amendment]
[0005]
[Working] Since the grooves are formed as straight-line oblique grooves having a prescribed tilt angle against the rotary axis or the generating line of the rotary driving unit, the straight-line oblique grooves, which are set at a tilted angle to the rotary axis or the generating line of the rotary driving unit like a pulley, the pulley is contacted at a contact point which has a size close to a point. This can reduce or suppress the generation of the sounds caused by the rotary driving unit and the straight-line oblique grooves hitting or contacting each other.

[Amendment 2]
[Amended Document Name] Detailed description
[Amended Section Number] 0006
[Nature of Amendment] Alteration

/6

[Content of Amendment]
[0006]
[Embodiments] Embodiments of flat belts under this invention are explained next with help from illustrating figures. Figure 1 and Figure 2 show a perspective view and a side view of the flat belt 10 in Embodiment 1 as it is wrapped between and driven by a pair of drive-side and driven-side pulleys 20 and 20. Figure 3 and Figure 4 show, respectively, a top view as seen from the side of the inside contact surface between the flat belt 10 unit and the pulley 20, as well as a side cross-sectional view, of the flat belt 10. The belt body 11 can be made from rubber elastic materials such as urethane rubber, nitrile rubber, or chloroprene rubber through an extrusion process, a cast-molding process, or a press-molding (vulcanization) process as was shown in conventional cases. Further, in order to enhance the strength against the tensile force working in the longitudinal direction of the belt during operation, multiple parallel tension core wires 12 made from steel wires, aramid fiber or glass fiber are buried in the width direction of the belt in the belt body 11.

[Amendment 3]
[Amended Document Name] Detailed description
[Amended section number] 0009
[Nature of Amendment] Alteration

[Content of Amendment]

[0009] Here, test material A will be the conventional belt shown in Figure 11 and Figure 12; test material C will be the flat belt 10 of Embodiment 1 of this invention; and test material C will be a flat belt that does not have conventional right-angle grooves or the straight-line oblique grooves 13 of this embodiment. As shown in Figure 5, these three test materials A, B, and C are wound between a pair of pulley 20 and 20. Then, a noise meter 30 is placed at 50 mm distance, for example, from the location where each of the test materials begins to contact the drive-side pulley 20, to measure and compare the sound pressure levels of the noises generated by each test material A, B, and C. Here, the groove angle α of the right-angle groove 4 of conventional test material A is set to 90°, while the groove angle α of the straight-line oblique groove 13 of the test material B under Embodiment 1 is set at 60°. Further, the size specification used by each test material A, B, and C is the same. Namely, according to the Figure 3 and Figure 4 of Embodiment 1, the belt thickness shown by code T is 5 mm, the belt width shown by code B is 25 mm, the groove width b is 0.20 in, groove depth h is 1.5 mm, and the groove pitch P is 20 mm. Further, the driving condition is set as follows: The number of rotations N of the drive-side pulley 20 is set to 1500 rpm and 5 rpm. The belt tensile force F is set to 30~40 kgf.

[Amendment 4]
[Amended Document Name] Detailed description
[Amended Section Number] 0010
[Nature of Amendment] Alteration
[Content of Amendment]

[0010] The obtained results <u>(sound pressure levels of generated noise)</u> are shown in the table below and the graphs in Figure 6 and Figure 7.

Table

| | Driving pulley number of revolution | | | | | |
|---|---|---|---|---|---|---|
| Belt tensile force (kgf) | 1500 rpm | | | 5000 rpm | | |
| | A | B | C | A | B | C |
| 30 | 91 | 83 | 83 | 105 | 92 | 90 |
| 40 | 93 | 83.5 | 83 | 104 | 93 | 90 |
| 50 | 95 | 84 | 82 | 107 | 93 | 91 |
| 60 | 95 | 84 | 82.5 | 107 | 94 | 92.5 |
| 70 | 98 | 85 | 84 | 108 | 95 | 93 |

(in dB, test time background noise 75 dB)

[Amendment 5]
[Amended Document Name] Figure
[Amended Document Name] Figure 2
[Nature of Amendment] Alteration

[Content of Amendment]
[Figure 2]